

**ESTABLISHMENT AND REDISTRIBUTION OF
SPHENOPTERA JUGOSLAVICA OBENBERGER
(COLEOPTERA: BUPRESTIDAE) FOR BIOLOGICAL
CONTROL OF DIFFUSE KNAPWEED (*CENTAUREA
DIFFUSA* LAMARCK) IN THE MIDWESTERN AND
WESTERN UNITED STATES**

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Abstract.—*Sphenoptera jugoslavica* Obenberger (Coleoptera: Buprestidae) is a root boring beetle imported to the United States as a biological control agent against *Centaurea diffusa* Lamarck (Asterales: Asteraceae). United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine personnel and research collaborators conducted an intensive collection and redistribution program, releasing this biological control agent in 11 states and 61 counties from 1980 to 1996. Establishment and recovery has been confirmed in 8 states and 48 counties.

Key Words.—Insecta, biological control, weed, *Sphenoptera*, *Centaurea*.

Diffuse knapweed (*Centaurea diffusa* Lamarck) (Asterales: Asteraceae), an accidentally introduced European biennial, or short-lived perennial has invaded and lowered the productivity of rangeland, pasture, wildlands, and wastelands in North America. The plant is seed dependent for reproduction, survives on dry disturbed lands with a northern distributional range in British Columbia at latitude 51° N, and is found at altitudes ranging from 150 to over 900 m (Watson & Renney 1974). Diffuse knapweed has an elongated taproot and usually forms a rosette in the spring or fall (Watson & Renney 1974). The plant is adapted to remain in the rosette state for more than one year if climatic conditions or the stage of growth are not conducive to bolting and seed production, an adaptation that is controlled by vernalization (Thompson & Stout 1991).

In western North America diffuse knapweed was first collected in an alfalfa field in Klickitat County, Washington in 1907 (Howell 1959). No other collections were reported in Washington until the 1930's. By 1985, diffuse knapweed was reported in Washington (11 counties), Montana (10 counties), Idaho (5 counties), and Oregon (5 counties) (Roché & Talbott 1986). Between 1989 and 1993, diffuse knapweed infested area in Washington (Piper 1989) increased from 173,150 ha to 641,993 ha of rangeland (Roché 1994). To diminish the severity and to halt the rapid spread of *C. diffusa*, a complex of European phytophages has been evaluated and released against the weed in North America (Schroeder 1985, Müll-

er & Schroeder 1989, Rees et al. 1996). Importations have included the capitulum-attacking insects *Bangasternus fausti* (Reitter) (Coleoptera: Curculionidae) (1991), *Larinus minutus* Gyllenhal (Coleoptera: Curculionidae) (1991), *Urophora affinis* Frauenfeld (Diptera: Tephritidae) (1970), and *U. quadrifasciata* (Meigen) (Diptera: Tephritidae) (1970), and the root-destroying insects *Agapeta zoegana* L. (Lepidoptera: Cochylidae) (1984), *Pelochrista medullana* (Staudinger) (Lepidoptera: Tortricidae) (1983), *Pterolonche inspersa* Staudinger (Lepidoptera: Pterolonchidae) (1986), *Cyphocleonus achates* (Fahraeus) (Coleoptera: Curculionidae) (1987), and *Sphenoptera jugoslavica* Obenberger (Coleoptera: Buprestidae) (1979) (Story & Nowierski 1984).

Sphenoptera jugoslavica adults consume diffuse knapweed foliage and the larvae feed in the roots (Powell & Myers 1988). The adults emerge in early July and live up to 30 d. Mating begins within 1 to 2 d and oviposition within 5 to 12 d continuing for 7 to 22 d (Zwölfer 1976). The eggs are generally positioned between the appressed petioles of the rosette leaves and sometimes on the petioles. Oviposition is synchronized with plant growth, the eggs being laid on inactive rosettes in order to prevent them from being crushed or displaced during rapid plant growth (Zwölfer 1976, Powell & Myers 1988). A female *S. jugoslavica* produces about 47 eggs during her lifetime, laying 1 to 7 eggs per plant (Zwölfer 1976). Normally only one larva develops in a root (Harris & Shorthouse 1996). A newly hatched larva feeds externally on basal tissue prior to its first molt after which it tunnels into the root. The plant forms a spindle-shaped gall around the larva which feeds upon the cortical tissue lining the gall (Powell & Myers 1988, Harris & Shorthouse 1996). The entry tunnel leading to the gall and the gall itself are filled with frass. The beetle overwinters as a larva in the root and resumes feeding in the spring. Pupation begins in late May, and the pupal period lasts 15 to 21 d (Rees et al. 1996). Because of microclimatic variables that affect larval and pupal development, there is a staggered emergence of adults from May to July. Newly formed adults remain in the pupal chamber for 2 to 5 d before gnawing an exit hole near the root crown and emerging (Zwölfer 1976). The insect is univoltine.

MATERIALS AND METHODS

Sphenoptera jugoslavica was approved for release as a biological control agent for diffuse knapweed in the United States on 17 May 1979 by the United States Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), Plant Protection and Quarantine (PPQ). The beetle was first released in the United States in 1980 in California, Idaho, Oregon, Washington and in Montana (1983) by USDA, Agricultural Research Service. The release material originated in Greece (Table 1). Major releases of *S. jugoslavica* adults, collected at White Lake, British Columbia, Canada, were made in Idaho, Montana, Oregon, and Washington between 1987 to 1992 by USDA, APHIS, PPQ and research collaborators. Caged and uncaged releases of the biocontrol agent were made from 1987–1996 in Arizona, Colorado, Idaho, Montana, Nebraska, Nevada, Oregon, South Dakota, Utah, Washington, and Wyoming (Table 1). To document establishment, some cooperators were instructed to use insect nets to sweep in concentric circles starting at the point of release and working their way outward to a distance of approximately 6 m. Sweeping was conducted in mid-July during the

Table 1. *Sphenoptera jugoslavica* releases and status in the midwestern and western United States, 1983-1996.

State	County	Release Year	Status
Arizona	Coconino	1993	Not established
	Gila	1994	Not established
Colorado	Archuleta	1991	Not established
	Boulder	1991	Not established
	Douglas	1991, 1993-1994	Established ^a
Idaho	Jefferson	1992	Not established
	Benewah	1994	Not monitored
	Blaine	1987	Not monitored
	Camas	1990	Not monitored
	Gooding	1990	Established
	Jerome	1987-1989	Established
	Lincoln	1987	Established
Montana	Broadwater	1996	Not monitored
	Fergus	1990	Established
	Lewis & Clark	1983, 1989-1990	Established
	Mineral	1993	Not monitored
Nebraska	Sweet Grass	1994-1995	Recovered
	Pierce	1993, 1995	Not established
Nevada	Washoe	1994	Not established
Oregon	Baker	1993	Established
	Deschutes	1989	Established
	Gilliam	1989	Established
	Hood River	1989	Established
	Jackson	1983	Established
	Jefferson	1989	Established
	Lake	1989	Established
	Malheur	1989	Established
	Morrow	1989	Established
	Multnomah	1996	Recovered
	Sherman	1988	Established
	Umatilla	1989	Established
	Union	1989	Established
	Wallowa	1989	Established
	Wasco	1987-1989	Established
	Wheeler	1996	Recovered
	South Dakota	Shannon	1994, 1995
Tripp		1990	Established
Utah	Weber	1993, 1994	Established
Washington	Adams	1990	Established
	Asotin	1989	Established
	Benton	1988-1990	Established
	Chelan	1995	Established
	Columbia	1995	Established
	Ferry	1987	Established
	Franklin	1995	Established
	Garfield	1989	Established
	Grant	1988, 1993	Established
	Kittitas	1988	Established
	Klickitat	1985, 1989-1990, 1993	Established
	Lewis	1992	Established
	Lincoln	1989	Established

Table 1. Continued.

State	County	Release Year	Status
	Okanogan	1983, 1985-1987, 1991-1993	Established
	Skamania	1988	Established
	Spokane	1988, 1989, 1990, 1993	Established
	Stevens	1985-1989, 1991, 1993-1995	Established
	Walla Walla	1985-1986, 1989	Established
	Whitman	1984, 1986, 1989	Established
Washington	Yakima	1988-1990	Established
Wyoming	Johnson	1995	Established
	Lincoln	1995	Not established
	Natrona	1994	Established

^a *Sphenoptera jugoslavica* is considered established if larvae or adults are recovered the second year after release.

latter part of the day from 1700 to 2000 h on calm, warm, dry days. Sites in Colorado, Idaho, Montana, Nebraska, Utah, Washington, and Wyoming were personally (R. F. L.) visited during March and 20 plants were collected randomly within 6 m of the release point and taken to a laboratory where they were dissected to ascertain larval presence.

The buprestid is considered established if larvae or adults were recovered the second year after release. Collection of adult *S. jugoslavica* for redistribution is recommended when 25% of a 20 root sample is infested with larvae.

RESULTS AND DISCUSSION

Sphenoptera jugoslavica has been released in 11 states and 61 counties (Table 1). Establishment has been confirmed in all states except Arizona, Nebraska, and Nevada. In Colorado, establishment and redistribution has occurred in Douglas County from the 1991-1994 releases; no recoveries were made in the other release counties. In Idaho, confirmed establishment occurred in Jerome and Lincoln Counties from 1987-1989 releases. In Montana, establishment occurred in Fergus and Lewis & Clark Counties from 1987-1990 releases. Beetles collected from Lewis & Clark County were released and later recovered in Sweet Grass County. In Oregon, establishment occurred in 16 counties from 1987-1990 releases. Adult *S. jugoslavica* are strong fliers and have readily colonized uninfested knapweed stands in Oregon. In South Dakota, establishment occurred in Shannon and Tripp counties from 1990, 1994, and 1995 releases. In Utah, Weber county establishment occurred from 1993-1994 releases and in Washington county establishment occurred in 20 counties from 1987-1995 releases. In Wyoming establishment occurred in Johnson and Natrona counties from 1994-1995 releases (Table 1). Intrastate collections and redistribution of *S. jugoslavica* in Montana, Oregon, Utah, Washington, and Wyoming have been made from established populations.

Sphenoptera jugoslavica is presently well established in the midwestern and western United States. Extensive collection and redistribution has occurred in 5 states and researchers have noted that the bioagent is redistributing itself naturally. *Sphenoptera jugoslavica* will continue to spread unaided to other diffuse knapweed

infestations throughout the midwestern and western states. This movement should be monitored as the beetle invades new states and counties.

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